

CLAIMS

1. A composite material which is elastic, which exhibits a resistive load under deformation which increases with the rate of deformation, which is comminuted or uncommunited and which comprises i) a first polymer-based elastic material and ii) a second polymer-based material, different from i), which exhibits dilatancy in the absence of i) wherein ii) is entrapped in a solid matrix of i), the composite material being unfoamed or, when foamed, preparable by incorporating ii) with i) prior to foaming.
2. A composite material according to Claim 1 wherein first material i) and second material ii) are in intimate admixture; for example, as attainable by blending i) and ii) together.
3. A composite material according to Claim 1 or 2 wherein the polymer comprising the first material i) comprises EVA or an olefin polymer, for example polypropylene or an ethylene polymer such as high pressure polyethylene (LDPE), LLDPE or HDPE.
4. A composite material according to Claim 1 or 2 wherein the polymer comprising the first material i) comprises an elastomer.
5. A composite material according to Claim 4 wherein the elastomer is a natural elastomer, such as latex rubber.
6. A composite material according to Claim 4 wherein the elastomer is a synthetic elastomer.
7. A composite material according to Claim 6 wherein the synthetic elastomer is a silicone rubber, a polyurethane or an EP rubber such as EPDM.

8. A composite material according to Claim 6 wherein the synthetic elastomer is a thermoplastic elastomer.

9. A composite material according to Claim 8 wherein the thermoplastic elastomer comprises a polyester.

10. A composite material according to any one of the preceding claims wherein the polymer comprising the second material ii) is selected from silicone polymers exhibiting dilatant properties.

11. A composite material according to Claim 10 wherein the silicone polymer is selected from borated siloxane polymers.

12. A composite material according to Claim 11 wherein the silicone polymer is selected from filled polyborodimethylsiloxanes.

13. A composite material according to any one of the preceding claims which is comminuted.

14. A process for the preparation of a composite material according to Claim 1, which process comprises:

- a) melting the polymer intended to comprise the first material i); and
- b) blending the polymeric dilatant intended to comprise the second material ii) therewith.

15. A process according to Claim 14 wherein the polymer intended to comprise the first material i) is defined in any one of Claims 3 to 9 and/or the polymeric dilatant intended to comprise the second material ii) is defined in any one of Claims 10 to 12.

16. A process according to Claim 14 or 15 wherein the polymeric dilatant is melted prior to and/or during the blending step (b).

17. A process according to Claim 14, 15 or 16 wherein, after blending and cooling, the composite material so formed is c) comminuted.
18. A composite material prepared by the process of any one of Claims 14 to 17.
19. A composite material according to any one of Claims 1 to 13 and 18 which has subsequently been foamed.
20. A composite material according to Claim 19 wherein the foam is a closed cell foam.
21. A composite material according to Claim 19 or 20 wherein at least part of the polymeric dilatant ii) is included within cell walls of the foam.
22. A composite material according to Claim 19, 20 or 21 wherein the cells include, as pneumatogen, a gas.
23. A composite material according to Claim 22 wherein the gas comprises nitrogen.
24. A process for the preparation of a composite material according to any one of Claims 19 to 23, which process comprises:
 - d) incorporating an unfoamed composite material, or a mixture of i) and ii), as defined in any one of Claims 1 to 13 or 18, in the barrel of an injection moulding machine including means for supplying a pneumatogen thereinto;
 - e) bringing the material defined in d) to an elevated temperature and an elevated pressure such that it is in molten form;
 - f) supplying a pneumatogen to the barrel; and

g) reducing the pressure of the heated composite material thereby causing foaming of the composite material.

25. A process according to Claim 24 wherein the pressure is reduced in step g) by injecting the composite material into a mould or extruding the composite material.

26. A process for the preparation of a composite material according to any one of Claims 19 to 23, which process comprises:

- h) incorporating an unfoamed composite material, or a mixture of i) and ii), as defined in any one of Claims 1 to 13 or 18 into a hermetic container including means for supplying a pneumatogen thereinto;
- j) bringing the composite material to an elevated temperature and an elevated pressure; and
- k) injecting pneumatogen into the hermetic container; and
- l) reducing the pressure of the heated composite material thereby causing foaming of the composite material.

27. A process according to Claim 26 wherein the interior of the container is formed as a mould.

28. A process for the preparation of a composite material according to Claims 19 to 23, which process comprises:

- m) incorporating with an unfoamed composite material, or with one or both components of a mixture of i) and ii), as defined in any one of Claims 1 to 13 or 18 microspheres comprising a plastic shell which hermetically encapsulates a gas or vapour;
- n) bringing the material defined in m) to an elevated temperature and pressure; and

30

o) reducing the pressure of the heated composite material thereby causing the expansion of the microspheres and foaming of the composite material.

29. A process according to Claim 28 operated on a continuous basis.

30. A foamed composite material prepared by the process of any one of Claims 24 to 29.

31. A shaped article comprising a composite material according to any one of Claims 1 to 13, 18, 19 to 23 and 30.

32. A shaped article as claimed in Claim 31 in the form of a sheet, film, filament or fibre.

33. A fibre which comprises a core of second material ii) within a sheath of first material i).

34. A fibre according to Claim 33 wherein the core is hollow.

35. A fibre according to Claim 33 or 34 wherein the first material i) is defined in any one of Claims 3 to 9 and/or the second material ii) is defined in any one of Claims 10 to 12.

36. A textile or web including filaments or fibres as claimed in any one of Claims 32 to 35.

37. An impact protection system including a composite material as claimed in any one of Claims 1 to 13, 18, 19 to 23 and 30; a shaped article as claimed in any one of Claims 31 to 35 or a textile or web as claimed in Claim 36.

38. An impact protection system according to Claim 37 associated with a rigid or semi-rigid component.

39. An impact protection system according to Claim 37 or 38 associated with a textile layer.

40. An impact protection system, for example footwear, according to any one of Claims 37 to 39 wherein the composite material is as claimed in Claim 30 when dependent from Claims 28 or 20 which is self-moulding in service.

AMENDED CLAIMS

[Received by the International Bureau on 25 November 2004 (25.11.2004);
original claims 1-40 replaced by amended claims 1-40 (5 page)]

1. A composite material which is elastic, which exhibits a resistive load under deformation which increases with the rate of deformation, which is comminuted or uncomminuted and which comprises i) a first polymer-based elastic material and ii) a second polymer-based material, different from i), which exhibits dilatancy in the absence of i) wherein ii) is entrapped in a solid matrix of i), the composite material being unfoamed or, when foamed, preparable by incorporating ii) with i) prior to foaming, the first material i) and second material ii) being in intimate admixture.
2. A composite material according to Claim 1 wherein the admixture is attainable by blending i) and ii) together.
3. A composite material according to Claim 1 or 2 wherein the polymer comprising the first material i) comprises EVA or an olefin polymer, for example polypropylene or an ethylene polymer such as high pressure polyethylene (LDPE), LLDPE or HDPE.
4. A composite material according to Claim 1 or 2 wherein the polymer comprising the first material i) comprises an elastomer.
5. A composite material according to Claim 4 wherein the elastomer is a natural elastomer, such as latex rubber.
6. A composite material according to Claim 4 wherein the elastomer is a synthetic elastomer.
7. A composite material according to Claim 6 wherein the synthetic elastomer is a silicone rubber, a polyurethane or an EP rubber such as EPDM.
8. A composite material according to Claim 6 wherein the synthetic elastomer is a thermoplastic elastomer.

9. A composite material according to Claim 8 wherein ~~the~~ thermoplastic elastomer comprises a polyester.

10. A composite material according to any one of the preceding claims wherein the polymer comprising the second material ii) is selected from silicone polymers exhibiting dilatant properties.

11. A composite material according to Claim 10 wherein the silicone polymer is selected from borated siloxane polymers.

12. A composite material according to Claim 11 wherein the silicone polymer is selected from filled polyborodimethylsiloxanes.

13. A composite material according to any one of the preceding claims which is comminuted.

14. A process for the preparation of a composite material according to Claim 1, which process comprises:

- a) melting the polymer intended to comprise the first material i); and
- b) blending the polymeric dilatant intended to comprise the second material ii) therewith.

15. A process according to Claim 14 wherein the polymer intended to comprise the first material i) is defined in any one of Claims 3 to 9 and/or the polymeric dilatant intended to comprise the second material ii) is defined in any one of Claims 10 to 12.

16. A process according to Claim 14 or 15 wherein the polymeric dilatant is melted prior to and/or during the blending step (b).

17. A process according to Claim 14, 15 or 16 wherein, after blending and cooling, the composite material so formed is c) comminuted.

18. A composite material prepared by the process of any one of Claims 14

to 17.

19. A composite material according to any one of Claims 1 to 13 and 18 which has subsequently been foamed.

20. A composite material according to Claim 19 wherein the foam is a closed cell foam.

21. A composite material according to Claim 19 or 20 wherein at least part of the polymeric dilatant ii) is included within cell walls of the foam.

22. A composite material according to Claim 19, 20 or 21 wherein the cells include, as pneumatogen, a gas.

23. A composite material according to Claim 22 wherein the gas comprises nitrogen.

24. A process for the preparation of a composite material according to any one of Claims 19 to 23, which process comprises:

- d) incorporating an unfoamed composite material, or a mixture of i) and ii), as defined in any one of Claims 1 to 13 or 18, in the barrel of an injection moulding machine including means for supplying a pneumatogen thereinto;
- e) bringing the material defined in d) to an elevated temperature and an elevated pressure such that it is in molten form;
- f) supplying a pneumatogen to the barrel; and
- g) reducing the pressure of the heated composite material thereby causing foaming of the composite material .

25. A process according to Claim 24 wherein the pressure is reduced in step g) by injecting the composite material into a mould or extruding the composite material.

26. A process for the preparation of a composite material according to any one of Claims 19 to 23, which process comprises:

- h) incorporating an unfoamed composite material, or a mixture of i) and ii), as defined in any of Claims 1 to 13 or 18 into a hermetic container including means for supplying a pneumatogen thereinto;
- j) bringing the composite material to an elevated temperature and an elevated pressure; and
- k) injecting pneumatogen into the hermetic container; and
- l) reducing the pressure of the heated composite material thereby causing foaming of the composite material.

27. A process according to Claim 26 wherein the interior of the container is formed as a mould.

28. A process for the preparation of a composite material according to Claims 19 to 23, which process comprises:

- m) incorporating with an unfoamed composite material, or with one or both components of a mixture of i) and ii), as defined in any one of Claims 1 to 13 or 18 microspheres comprising a plastic shell which hermetically encapsulates a gas or vapour;
- n) bringing the material defined in m) to an elevated temperature and pressure; and
- o) reducing the pressure of the heated composite material thereby causing the expansion of the microspheres and foaming of the composite material.

29. A process according to Claim 28 operated on a continuous basis.

30. A foamed composite material prepared by the process of any one of Claims 24 to 29.

31. A shaped article comprising a composite material according to any one of Claims 1 to 13, 18, 19 to 23 and 30.

32. A shaped article as claimed in Claim 31 in the form of a sheet, film, filament or fibre.

33. A shaped article according to Claim 32 in the form of a fibre.

34. A fibre according to Claim 33 wherein the core is hollow.

35. A fibre according to Claim 33 or 34 wherein the first material i) is defined in any one of Claims 3 to 9 and/or the second material ii) is defined in any one of Claims 10 to 12.

36. A textile or web including filaments or fibres as claimed in any one of Claims 32 to 35.

37. An impact protection system including a composite material as claimed in any one of Claims 1 to 13, 18, 19 to 23 and 30; a shaped article as claimed in any one of Claims 31 to 35 or a textile or web as claimed in Claim 36.

38. An impact protection system according to Claim 37 associated with a rigid or semi-rigid component.

39. An impact protection system according to Claim 37 or 38 associated with a textile layer.

40. An impact protection system, for example footwear, according to any one of Claims 37 to 39 wherein the composite material is as claimed in Claim 30 when dependent from Claims 28 or 20 which is self-moulding in service.